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(71) Applicant *(for all designated States except US)*: **OBSCHESTVO S OGRANICHENNOI OTVETSTVENNOSTIJU "KORVET-LIGHTS"** [RU/RU]; ul. Mironovskaya, 10a, Moscow, 105058 (RU).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **ABRAMOV, Vladimir Semenovich** [RU/RU]; ul. 26 Bakinskich komissarov, 10-2-95, Moscow, 117526 (RU). **DENISOV, Sergei Dmitrievich** [RU/RU]; ul. Abramtsevskaya, 12-474, Moscow, 127576 (RU). **SCHERBAKOV, Nikolai Valentinovich** [RU/RU]; ul. Pervaya Novokuzminskaya, 25-37, Moscow, 109377 (RU). **MICHEEV, Petr Alexeevich** [RU/RU]; pr. Ispytatelei, 20-531, St.Petersburg, 197227 (RU). **PUYSHA, Alexandr Eduardovich** [RU/RU]; ul. Bryantseva, 4-38, St.Petersburg, 197269 (RU).

(74) Agent: **OOO "AGENCY OF INTELLECTUAL PROPERTY PROTECTION AND DEVELOPMENT "ERMAKOVA, STOLYAROVA AND ASSOCIATES"**; Pokrovsky bul. 3-430 Moscow, 109028 (RU).

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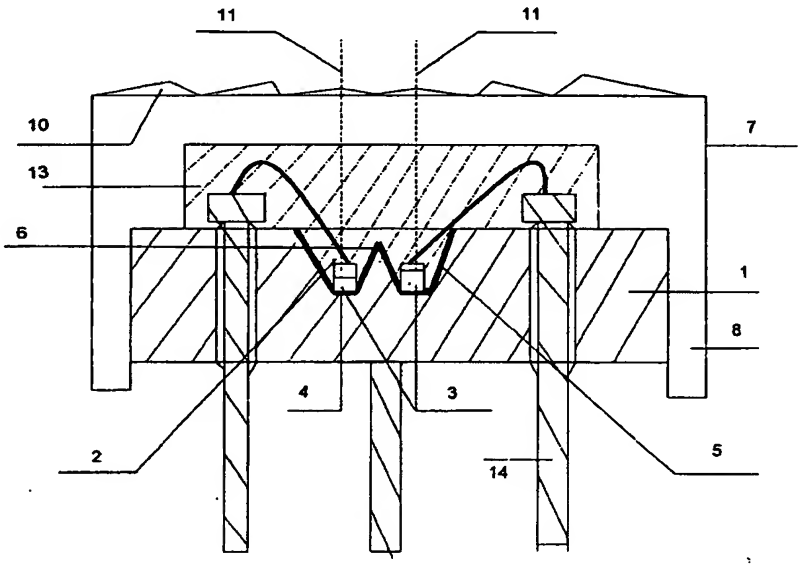
(54) Title: LUMINESCENT DIODE DEVICE



(57) Abstract: The invention falls within the realms of electronic engineering specifically of the luminescent diode devices and is intended for application in semi-conductor industries. The luminescent diode device contains crystals of light emitter located in a recess of a substrate having a reflecting side surface and also a concentrating lens. The device is equipped with a reflector installed in a recess of a substrate and the lens contains N-number of optical elements, wherein N is a number of crystals of light emitter. In this case the optical axis of each N-optical element coincides with the optical axis of the corresponding crystal.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

LUMINESCENT DIODE DEVICE.

The invention relates to the field of electronic engineering, namely to luminescent diode devices and is intended for application in semi-conductor industries.

Luminescent diodes are widely used in signaling about the mode of operation of various devices, in full-coloured screens of public use of any format, in information panels, traffic lights, illuminators, etc.

The use of luminescent diodes instead of incandescent lamps considerably increases the reliability and reduces the power consumption of equipment. As this takes place, in many cases required are the luminescent diodes with a wide range of colours and shades of light flow, varying in size and uniformity of luminous spot and in emissive power (luminous intensity).

The most important parameter of luminescent diodes is the emissive power depending mostly on the strength of flowing forward electrical current and on the value of thermal resistance of the holder on which a crystal of light emitter is installed.

If taking into consideration the technical essence, the closest one to the offered luminescent diode device is a device containing the crystals of light emitter placed in the recess of substrate which has a reflecting side surface and a concentrating lens (International patent Application № PCT/RU97/00070, International Publication № WO98/42031 dated 24.09.98). The drawback of such device is the lack of concentration of emission directionality and low light intensity.

The technical result of the offered invention is increasing of emissive power (luminous intensity) of a luminescent diode and possibility of varying of an angle of vision and of spatial diagram of emission directionality, as well as increasing of the resolution ability. The set task is solved through that the luminescent diode containing the crystals of light emitter placed in the recess of substrate having the light-reflecting side surface and a concentrating lens, is equipped with a reflector installed in the substrate recess and the lens contains N-number of optical elements, wherein N is a number of crystals of light emitter. In this case the optical axis of each N-optical element coincides with the optical axis of the corresponding crystal.

The reflector can be made, for example, in the form of a cone or pyramid and is installed between the crystals or inside a contour formed by the lines connecting centers of the crystals.

The side surface of the recess of substrate can be made in the form of solid of revolution, for example, in the form of conical surface.

As crystals the crystals of one- or many-coloured emission can be used.

The depth of the recess of substrate is chosen so that the ratio thereof to the thickness of crystals makes up (2 - 4): 1.

The ratio of the reflector's height to the thickness of crystals makes up (1,3 - 1,5) :1.

Shown in Figure 1 is the device in section.

Shown in Figure 2 is the exterior view of the device with a spherical lens.

Shown in Figure 3 is the exterior view of the device with a lens executed in the form of raster.

Shown in Figure 4 is the view of the device from above - view of the device from above with a lens executed in the form of raster.

Shown in Figure 5 is the exterior view of the cover.

Shown in Figure 6 is the view of the device from below.

The offered luminescent diode device contains a substrate (1) with the recess (2) on which the crystals (3) of light emitter are installed. The recess of substrate has a flat bottom (4) and a side reflecting surface (5) made in the form of a solid of revolution, for example, in the form of conical surface. A number of mounting seats for crystals in the said recess corresponds to the number of crystals of light emitter.

The device is equipped with a reflector (6) made in the form of a cone or a pyramid. In this case the reflector is installed inside the contour formed by the lines connecting the centers of crystals.

Due to the reflecting side surface of the substrate recess and to the conical or pyramidal reflector available all the side emission of each of the crystals is directed towards the optical element - lens (7) forming the indicatriss of emission.

The lens is installed on the transparent cover (8) of device and can compose the whole unity with the cover, for example, in the form of spherical cylinder (semi-spherical lens with the cylindrical base (9)), or in the form of ellipsoid-cylinder or in the form of a flat raster (10). The lens (7) contains N-number of optical elements,

wherein N is a number of crystals of light emitter. The optical axis (11) of each of the optical elements of the lens (7) coincides with the optical axis of the corresponding crystal (3).

On the bottom side of the base of the cover the guide pins (12) are provided which are placed according to the positional openings (not shown in the Figure).

The thickness of the spherical cylinder base (9) does not exceed the value of radius of the lens - (R). The space between the base of the concentrating lens and the upper surface of the substrate is filled with polymeric sealing compound (hermetic) (13).

The depth of the flat mounting seat for crystals of light emitter exceeds the thickness of the crystal but does not exceed four thicknesses of the crystals. The height of the conical or pyramidal reflector exceeds the thickness of the very crystal in 1,3 to 1,5 times. The size of the mounting seat of the crystal (3) of light emitter exceeds the size of diagonal of its lower face in 1,5 to 2. The mentioned conditions make it possible to concentrate at maximum the emission along the optical axis of the luminescent diode.

The work of the luminescent diode device can be described as follows.

When the electrical voltage which ensures the flow of forward current through the crystals (3) of light emitter is supplied to the connecting outlets (14) of the luminescent diode device, the crystals (3) begin to emit light. The emission from the upper surface of the crystal (3) of light emitter and from its lateral faces after reflecting by the side surface (5) of the recess and by the conical reflector (6) falls on a layer of polymeric sealing compound (13) and after that, on the optical element-lens (7) forming the emission of required indicatriss.

For achieving of luminescence colours variety they let pass through the crystals (3) of light emitter the direct forward current of the set value or impulse forward current of required amplitude and impulses porosity.

Depending on the required diagram of directionality of emission a corresponding configuration of lens is applied. Availability of polymeric sealing compound (hermetic) (13) and of the semi-spherical lens cylindrical base having a thickness which does not exceed the radius of lens, ensures reduction of emission intensity losses and also the required diagram of emission directionality. The offered construction of the luminescent diode device ensures the use of the lateral

luminescence of the crystals of light emitter (3) and to increase the emission intensity (2 times).

A metallic substrate (1) having a thickness equal to or exceeding four thicknesses of the crystal of light emitter (3) ensures effective scattering of consumed power from lower face of substrate.

The light emitter crystals with red, orange, yellow, green, blue and dark blue colours of luminescence may be used in monochromatic version of the luminescent diode.

Colour saturation and adequate perception of information may be obtained by additional painting of a cover with appropriate colour by adding pigment in the course of manufacture thereof or of dispersing agent therein (for example, crushed optical quartz). Application of dispersing agent improves the luminescence perception due to the increase of luminous spot in size without destroying the physical-chemical properties of cover material.

The increasing of emission intensity or of luminescence of device as well as of the required coloures' spectrum is achieved by installation of the reflector in the substrate recess in that way that the lateral emission of each crystal face would be directed towards the optical element-lens forming the emission indicatriss.

The construction of concrete luminescent diode device made in accordance with the present invention contains a metallic-glass holder of steel 1 mm thick, with connected thereto outlets 0,55 mm in diameter. Reflecting conical surface has a depth of 0,6 mm, diameter on the substrate surface is equal to 2,4 mm, diameter of the flat bottom equipped with mounting seats for crystals is 1,5 mm. The cover is cast in plastic mass - polycarbonate of «Lexan» type. The radius of a semi-spherical lens is equal to 5 mm, the height of cylindrical base is 3 mm, the distance between a substrate and base is varied within the limits of 1-3 mm. A sealing (polymeric) compound of 159-322 make is used.

Crystals emitting red light with wave 633 nm in length, green light with wave 525 nm in length and dark blue light with wave 470 nm in length serve as crystals of light emitter. To install the crystals of light emitter and to coat the junctions of conductors to the isolated connecting outlets based on silver, a current-transmitting glue of TOK-2 is applied.

Described construction of luminescent diode device ensures thermal resistance to be 170° C/W and increasing of the forward current, flowing through

the luminescent diode, up to 80 mA without losses of linearity of lux-ampere characteristic. This makes possible to obtain luminous intensity more than 1.5 Cd at carbon temperature 90°.

Shown below are the properties/characteristics of super-bright full-coloured luminescent diodes developed on the base of the present invention.

The said devices contain at three light emitter crystals each (of red, green and dark blue colours) mounted under the common optical dome in hermetic plastic corpse with a square base and plastic cover of 10 mm in diameter being at its essence a semi-spherical lens.

Examples of concrete execution of the offered luminescent diode device may be illustrated by values set forth in Table 1 and Table 2.

Shown in Table 1 are properties/characteristics of bright full-coloured luminescent diodes.

Table 1.

Type of device	Lens colour	Length of wave/nm	Luminous intensity Idev.=40 mA Min mCd	Luminous intensity Idev.=40 mA Type mCd	Angle of emission $2\theta\ ½I_v$ degr.
SID-3	transparent	630	1200	2000	90
		525	1500	2800	90
		470	500	800	90
SID-3D	dispersed	630	300	600	120
		525	350	800	120
		470	100	200	120

Shown in Table 2 are maximum operating properties/characteristics and other properties of semi-conducting luminescent diodes.

Table 2.

№	Maximum parameters at 25°C	
1.	Maximum limit forward current	300 mA
2.	Average forward current	60 mA
3.	Maximum forward current	70 mA
4.	Dispersed intensity	300 mW
5.	Reverse voltage (at reverse current=100 mkA)	5 V
6.	Operating temperature	-55 up to + 100°C
7.	Temperature of casting by lead solder	260°C in 5 seconds

Described construction of a luminescent diode provides high technical properties thereof ensuring powerful emission of narrow directionality. The offered diode can find its wide industrial application in the development and manufacture of semi-conducting devices in various industries.

CLAIMS

1. The luminescent diode device containing crystals of light emitter located in a recess of a substrate having a light-reflecting side surface and also a concentrating lens, distinguished by the fact that the device is equipped with a reflector installed in a recess and the lens contains N-number of optical elements, wherein N is a number of crystals of light emitter, in this case the optical axis of each N-optical element coincides with the optical axis of the corresponding crystal.
2. The luminescent diode device as defined in Claim 1, wherein the reflector is made in the form of a cone.
3. The luminescent diode device as defined in Claim 1, wherein the reflector is made in the form of a pyramid.
4. The luminescent diode device as defined in Claim 1, wherein the reflector is installed inside a contour formed by lines connecting the centers of crystals.
5. The luminescent diode device as defined in Claim 1, wherein the side surface of the substrate recess is made in the form of the surface of solid of revolution.
6. The luminescent diode device as defined in claims 1, 5, wherein the side surface of the substrate recess is made in the form of conical surface.
7. The luminescent diode device as defined in Claim 1, wherein the crystals of one-coloured emission serve as crystals.
8. The luminescent diode device as defined in Claim 1, wherein the crystals of many-coloured emission serve as crystals.
9. The luminescent diode device as defined in Claim 1, wherein the ratio of the substrate recess depth to the thickness of crystals is (2 - 4): 1.
10. The luminescent diode device as defined in Claim 1, wherein the ratio of the reflector height to the thickness of crystals is (1,3 - 1,5): 1.

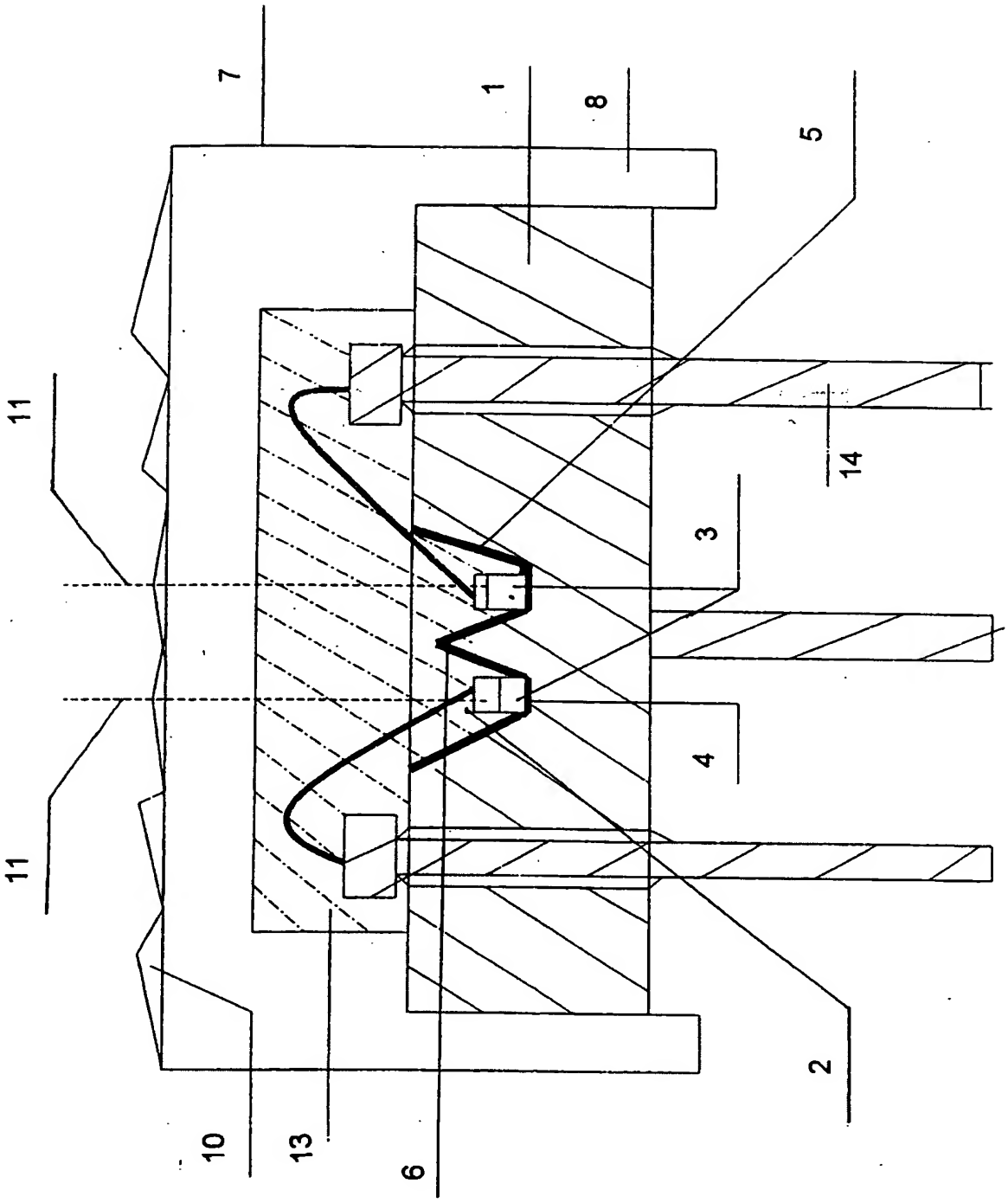

Fig.1

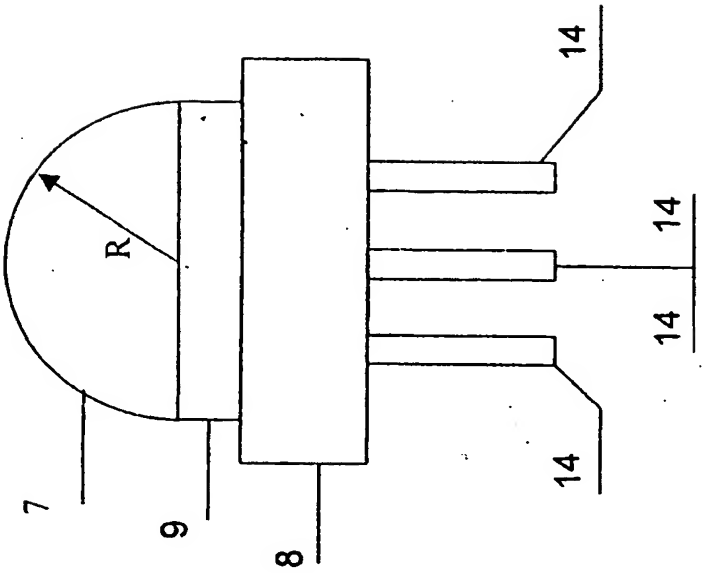

Fig.2

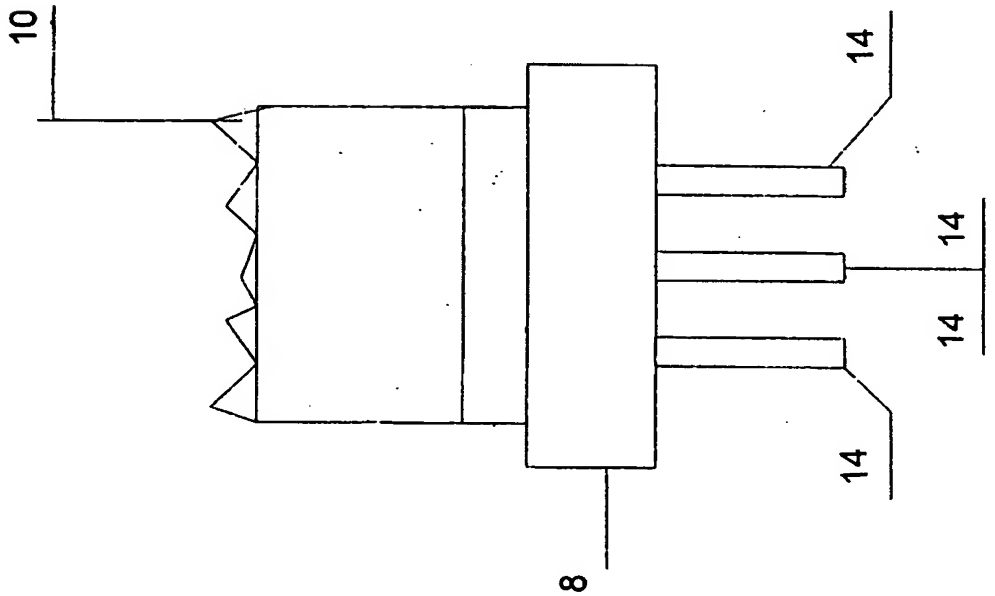

Fig.3

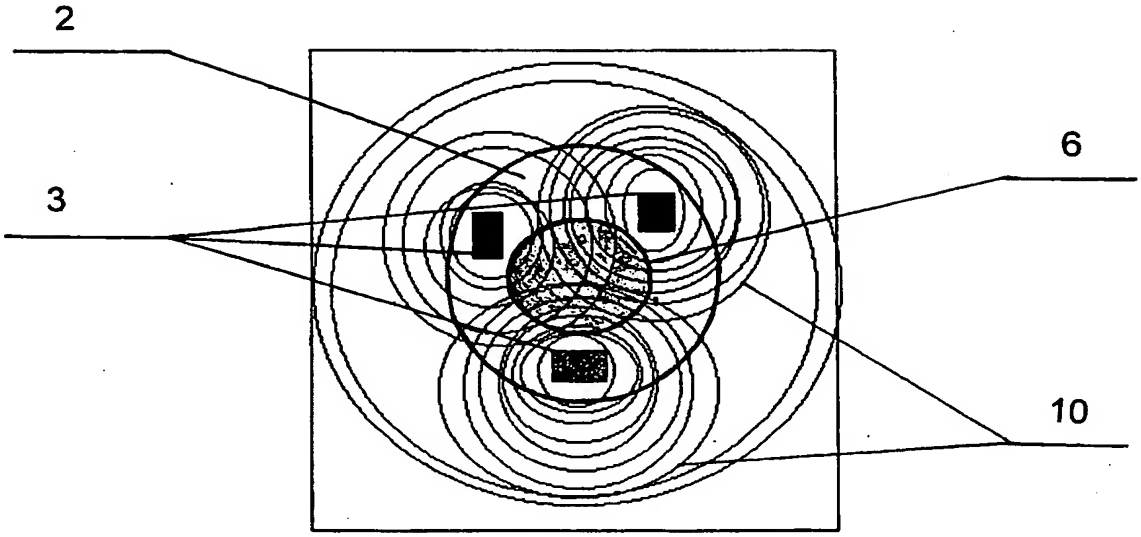

Fig. 4

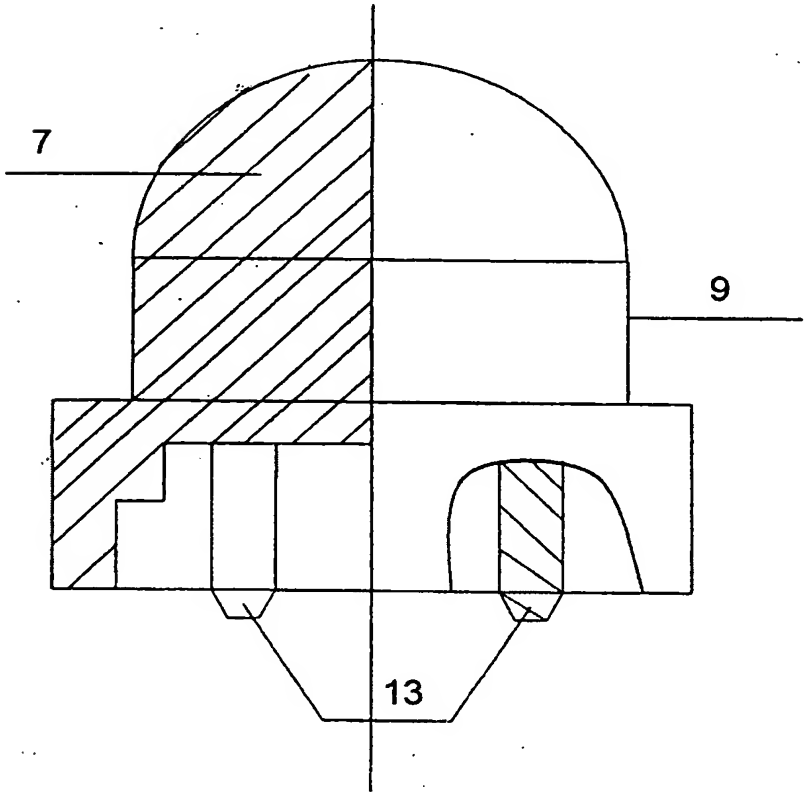

Fig. 5

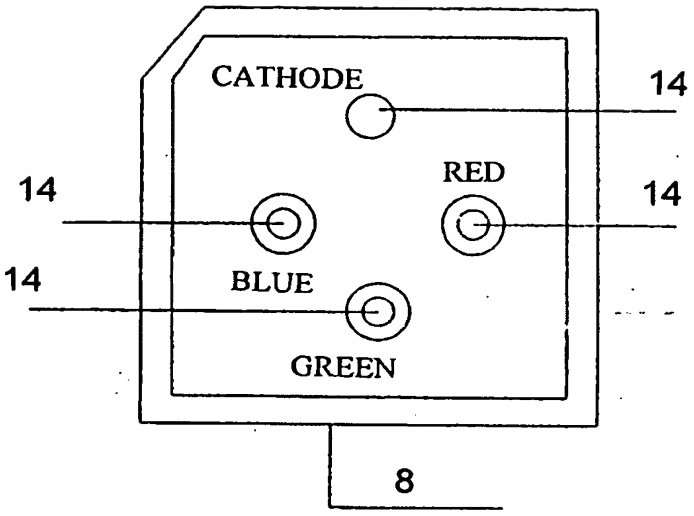

Fig.6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/RU 99/00387

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 : H01L 33/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H01L 33/00, F21 Q 1/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	RU 2133068 C1 (ABRAMOV V.S. et al.) 10 July 1999 (10.07.99), claims	1-3, 5-9
Y	RU 2137978 C1 (OTKRYTOE AKTSIONERNOE OBSCHESTVO « LOMO » 20 September 1999 (20.09.99), col.8-11, fig.4	1-3, 5-9
A	US 3981023 A (NORTHERN ELECTRIC COMPANY LIMITED) 14 September 1976 (14.09.76)	1-10
A	RU 2134000 C1 (ABRAMOV V.S. et al.) 27 July 1999 (27.07.99)	1-10
A	RU 2114492 C1 (ABRAMOV V.S. et al.) 27 June 1998 (27.06.98)	1-10

☐ Further documents are listed in the continuation of box C. ☐ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
30 May 2000 (30.05.2000)	13 July 2000 (13.07.2000)
Name and mailing address of the ISA/RU FIPS Russia, 121858, Moskva, Berezhkovskaya nab., 30-1	Authorized officer Telephone No. (095)240-58-88

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